Why invest in wind resource assessments and second opinions? (poster)

Landberg, L.; Myllerup, Lisbeth; Mortensen, Niels Gylling; Rathmann, Ole

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Lars Landberg, Lisbeth Myllerup, Niels G. Mortensen and Ole Rathmann
Risø National Laboratory, Roskilde. E-mail: lars.landberg@risoe.dk

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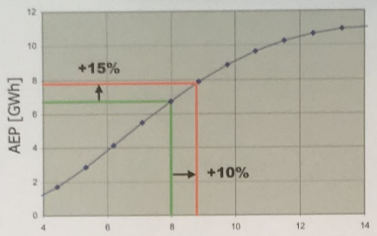
Mean wind speed and energy production

The Annual Energy Production (AEP) of a wind turbine depends on the distribution of mean wind speeds (Weibull distribution) at hub height.

The correct estimation of the mean wind speed and Weibull distribution is very important; an overestimation of the mean wind speed of 10% will cause AEP to be overestimated by approximately 15%.



Annual Energy Production (AEP) as function of mean wind speed U, Weibull k=2, air density of 1.225 kg/m³ for a typical wind turbine.

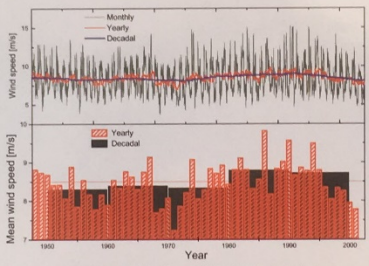
Important issues

- Wind data
- Long term variations
- Site specific power curves
- Model limitations
- Wake decay constant
- Offshore: tides, sea ice
- Sensitivity analysis

Quality of wind data

- The wind data must be accurate
  - –equipment design and specifications
  - –calibration of sensors (anemometers)
  - –careful mounting of sensors on mast
  - –verification of sensor outputs (QA)
- The wind data must be representative
  - –data collection for > 1 year (no seasonal bias)
  - –data recovery > 90% (missing data at random)
  - –data statistics for full years (no seasonal bias)
  - –careful siting of mast (similarity principle)
- The wind data must be reliable
  - –O&M, redundant sensors, wind index, ...

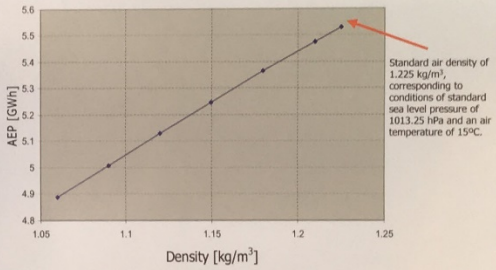
Long-term variations



Data from NCEP/NCAR reanalysis for a site in Ireland.

NCEP Reanalysis data provided by the NOAA-CIRES Climate Diagnostics Center, Boulder, Colorado, USA, from their Web site at http://www.cdc.noaa.gov/.

Air density



Annual Energy Production (AEP) as function of air density for Weibull A=8 m/s and k=1.9 for a typical wind turbine.

Model limitations

- Obstacles and sheltering effects
- Wind turbines near forest: roughness and zero displacement height
- Complex terrain: steep slopes and roughness effects
- Complex climatology: stability effects, katabatic and anabatic winds, sea and –land breezes

Qualified wind resource assessments and second opinions require expertise, experience and highly skilled staff, especially in projects where the conditions are close to or outside the operational envelope of the models.

Concluding remarks

- Wind-monitoring station(s) essential
  - –high-quality, reliable, on-site wind measurements
  - –turbulence intensity, extremes, gust, lull, solar insolation, ...
- Micro-scale modelling required, but has it's limitations
- Referencing to long-term wind variations essential
- Meso-scale modelling of regional wind climate very useful
  - –spatial variation of regional wind climate
  - –NCEP/NCAR reanalysis data may be used as input
  - –reliable results, even in complex topography, complex climatology and offshore
- The meso-/microscale methodology for resource assessment
  - –improved resource assessment and siting
  - –validated by comparison to wind measurements

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